

Final Report
August 24, 2006

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Grant Data

Title Assessment of efficiency and cost of banker plants for aphid control in spring flower crops

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States involved Massachusetts and New York

Years funded two years (2004-2006)

Funding amount \$40,096

Nontechnical Summary

NE US spring flower crops contribute ca 0.5 billion dollars annually to the economy. Dominant northeast crops are impatiens and geraniums. Pests include whiteflies, thrips, aphids and mites. We have developed effective, cost competitive biological controls for whiteflies in flower crops and are mid way toward doing the same for thrips. Aphids commonly appear in crops under biological control management. Non chemical controls for aphids are needed if growers are to be able to employ whitefly and thrips biological control without risk. Aphids make flowers unsightly and unsaleable. Aphid biological control options in greenhouse vegetables are well understood and in use. Application to flower crops has lagged. Greenhouse production in the northeastern US is over 90% flower production. We need to adapt the banker plant technology currently in use in Europe and Canada on vegetable crops, to flowers. The dominant aphids are *Aphis gossypii* and *Myzus persicae*. For each of these species, we need to assess the degree of efficacy and cost of *Aphidius colemani* banker plants under spring flower production conditions. We will run the needed trials in University greenhouses in MA and then in commercial greenhouses in both MA and NY. Controls that work in these states will work for the whole NE region. Ancillary activities needed in support of these trials include an initial aphid survey in the crop and screening potentially selective aphicides to find a compound to use for spot treating infestations of less common aphids, of species not susceptible to *A. colemani*.

Introduction

Economic importance of crop. Nationwide, in 1998 sales of flats, pots and hanging baskets of such plants as marigolds, impatiens, geranium, petunias, and cyclamen were approximately 2.5 billion dollars, which was 64% of all greenhouse floriculture sales (National Agricultural Statistical Service, 1999). The majority of these sales are concentrated in the spring crop. In 1998 in MA, CT, NY, NJ, MD, PA, and VA combined, there were over a half a billion dollars in sales of such floral crops, 20% of all U.S. production. Greenhouse businesses employ a large labor force, averaging 16 employees per business. Thus the 446 greenhouse operations in MA in 2001 (New England Agricultural Statistics Service, 2002) and the ca. 965 operations in NY likely generated over 20,000 jobs.

Importance of the pest to the crop. Aphids (especially *Aphis gossypii* and *Myzus persicae*) are a common problem on a wide variety of spring floral crops. In a survey of MA flower growers in 1996, growers reported applying an average of three pesticide applications per crop for aphids, second only to thrips (Smith, 1998). While this survey has not been repeated recently, little has changed in this regard. Failure to control aphids to low levels makes plants unsaleable. Use of pesticides for control of aphids can disrupt biological control of thrips, mites and whiteflies. For growers wishing to minimize pesticide use, aphid biological control options are needed. Current practice is proceeding based on an inadequate research base, largely guided by guesswork and insectary recommendations.

Risks from non-IPM methods for controlling the pest. There are two risks from non-IPM aphid control (with pesticides): (1) destruction of natural enemies and loss of biological control efficacy for whiteflies and other pests, and (2) increased exposure to workers to pesticide residues.

(1) The development of biological control, or integrated (BC+compatible pesticide) control for greenhouse pests has been a long standing goal of both the Van Driesche and Sanderson labs. We have been successful for whiteflies and work is in progress for thrips. The research proposed here builds on these earlier efforts. Since aphid infestations are more likely to develop once growers reduced pesticide use for these other pests, a biological control means of suppressing aphids strengthens the whole program.

(2) Reduction of pesticide use in greenhouses will benefit greenhouse workers. Greenhouse workers are often minimum wage employees who are the least sophisticated in protecting themselves from contact with potentially damaging pesticides. Conversion to biological control will improve this situation.

Reason for this study. The principal reason for this study was to determine if a new technology from the insectary industry (banker plants for aphid control) work well enough to be able to recommend them to growers. If aphids can be controlled with banker plants, it would increase grower adoption of biological control because adoption is often not embraced unless there are solutions for all pests likely to occur in the crop (growers want and need total packages of management, not fragments). This is a missing piece that now seems feasible but needs assessment of its efficacy.

Objectives

Obj. 1. Aphid/Crop Survey in MA and NY Greenhouses. The goal of this objective is to determine which aphids, on which crops, are the dominant species found in MA and NY on spring flower crops. While this information is known in superficial terms, this survey will provide quantitative data, which are lacking.

Was objective achieved or modified? This objective was met as planned. Aphids were surveyed in the proposed number of greenhouses in both NY and MA. Aphids were encountered and collected. Technicians were trained by Susan Halpert in Florida (Division of Plant Industries) in aphid identification. Aphids were identified and proportions of infestations (not individuals) by species were calculated and are presented in results.

Obj. 2. Assess the Efficacy of Banker Plants Systems for Biological Control of Aphids in Spring Flower Crops. We will assess the degree of aphid control provided by banker plants, examining the influences of aphid and plant species.

Was objective achieved or modified? Trials were run in UMASS greenhouses as proposed (four treatments, each replicated in whole greenhouses four times) with one modification. The plant material used in the trial was changed from geraniums and impatiens to pansies and margarite daisies. This was necessary in order to obtain strains of each test aphid species willing to feed on both test plants. Trials were run without problems, except one replicate that encountered hot weather that was unfavorable for the parasitoids.

Obj. 3. Compatibility of Selective Aphicides and *A. colemani*. In the laboratory, we will measure the effect of pyrethrozin and pyroproxifen on adults and mummies of *Aphidius colemani*.

Was objective achieved or modified? This objective is currently being run (August, 2006) and will be completed within the next 30 days. No technical difficulties have been encountered.

Obj. 4. Efficacy under Commercial Greenhouse Conditions. After the previous work, we will examine the efficacy of *A. colemani* in commercial growers in MA and NY.

Was objective achieved or modified? Trials in commercial greenhouses were run, as planned, in both MA and NY. Data collection in these commercial greenhouses was increased to include use of caged and uncaged blocks of artificially infested plants, with caged-infested plants serving as controls. This was done to enhance the test by creating a better control. As expected, conditions in commercial greenhouses were more variable than in University greenhouses. Events of interest that occurred included invasions of other natural enemies and more variation in how well banker plants worked. Also, in NY, there was an unexpected occurrence of foxglove aphid, a non-host for *Aphidius colemani*.

Approach

Obj. 1. Aphid/Crop Survey in MA and NY Greenhouses. This objective was met by two surveys, one in MA and one in NY, with a total of 20 greenhouses being visited in each state (n = 40 for total survey). At each greenhouse, crops being grown were

searched by the technicians or extension agents doing the survey and aphids were collected, with notes on their host plants and abundance. Aphids were preserved, taken to the laboratory and identified. From identifications, the relative frequencies by aphid species (based on number of infestations detected, not number of individual aphids) were calculated.

Obj. 2. Assess the Efficacy of Banker Plants Systems for Biological Control of Aphids in Spring Flower Crops. We obtained strains of melon and green peach aphids from colleagues until strains were found of both species that would feed on the same two flower crops. This was a challenging step that was not anticipated, strains having much narrower host ranges than the taxonomic species as a whole. We ran the trial with pansies and margarite daisies, in four identical greenhouses at UMASS, using the four treatments proposed. The treatments used aphids species as primary factor, with plant species as sub plots. One full greenhouse was used as a control. Sentinel plants were inoculated with aphids according to the proposed protocol, using aphids from our lab colonies. Data consisted of numbers of aphids for 6 to 8 weekly post-inoculation counts, in greenhouses either with or without banker plants (one per greenhouse) of *Aphidius colemani* on rye grass and grain aphids.

Obj. 3. Compatibility of Selective Aphicides and *A. colemani*. The two aphicides of interest (pymetrozine and pyriproxifen) are being screened in petri dishes under laboratory conditions for their impacts on *A. colemani* adults and mummies as planned. While this work is just now being done, this is a short task that is about half completed at the time of this report and no surprises have been encountered and none are anticipated. The work will be finished by the end of August, 2006.

Obj. 4. Efficacy under Commercial Greenhouse Conditions. The first plan for this activity was to place banker plants in commercial greenhouses and assess the level of aphids in the subsequent crops, in 7 greenhouses (4 in NY and 3 in MA). However, aphid infestations were irregular in their appearance, so we changed the design by adding two blocks of a one plant (pansies) and one aphid (*M. persicae*), one block being a caged control (not exposed to parasitoids because of the cage) and the other being exposed to the parasitoids from the banker plant, but in all other respects the same as the aphids in the cage (same plant, same aphid, same inoculation density and starting date). Crop plants were also sampled to detect natural occurring aphids and measure their abundance.

Progress

This is a final report. All proposed work has either been accomplished (Objectives 1-3) or is in progress, with a short term finish date (Obj. 4- to be completed by the end of August, 2006). In the previous 12 months two trials were conducted at UMASS, as well as trials at 7 commercial growers (4 in NY and 3 in MA). In addition, aphids collected in previous surveys were identified to species.

Results

Obj. 1 Aphid Greenhouse Survey in Spring Flower Crops. (MA and NY combined)

Of 51 aphid infestations detected in spring floral crops in greenhouses (n = 40) in MA and NY in 2004, the majority (52.9%) were green peach aphid (*M. persicae*). Unexpectedly, the cotton aphid (*A. gossypii*) was not the next most important, but rather was uncommon (5.9% of detected infestations). The second most common aphid was, rather, foxglove aphid (*A. solani*) (27.5%), a species that is not susceptible to *Aphidius colemani*, an important finding for use of this banker plant system, suggesting that combinations of *A. colemani* and *Aphidius ervi* (which does attack *A. solani*) may be desirable..

Table1. Numbers of aphid infestations, by species, detected in surveys in 2004 in MA and NY, 20 greenhouses in each state, in spring flower crops.

Species of aphid in detected infestation	No. of infestations detected (% of total)
<i>Myzus persicae</i>	27 (52.9%)
<i>Aphis gossypii</i>	3 (5.9%)
<i>Aulacorthum solani</i>	14 (27.5%)
<i>Ovatus crataegarius</i>	1 (2.0%)
<i>Macrosiphum sp.</i>	1 (2.0%)
<i>Aphis sp.</i>	2 (3.9%)
<i>Aphis spireacola</i>	1 (2.0%)
<i>Macrosiphum euphorbiae</i>	2 (3.9%)
Totals	51

Obj. 2. Greenhouse trials at UMASS. These trials were the most controlled and gave the best results. Under these conditions, banker plants in some replicates gave dramatic (99%) suppression of aphids, holding numbers to or below the initial inoculation rate (5 per plant on sentinel plants), in contrast to control plants on which peak densities reached levels up to several thousand per plant.

Results from greenhouse trials are being analyzed and space is insufficient here, except to present a list of conclusions and one table summarized the degree of aphid suppression (Table 2)

Table 2. Growth rates of aphid populations in treatments versus the control (data presented are ratios of final average treatment densities across replicates divided by final average for control replicates) (a 1% value here corresponds to a 99% control rate of the aphid numbers)

	One aphid species in greenhouse		Second aphid species also present	
	daisy	pansy	daisy	pansy
Green peach aphid	13%	34%	4%	50%
Cotton aphid	<1%	6%	<1%	56%

From an inspection of final aphids densities in control and treatment greenhouses, the following can be concluded:

1. Banker plants did not consistently suppress both aphids on both plants in all four replicates. In the second replicate in 2005 (done rather late, June 16-July 7), parasitism was scarcely detected, and parasitoids appeared to die from high greenhouse temperatures.
2. Margarite daisy (a chrysanthemum), in controls, was consistently a better host than pansy, for both aphids. However, the ratio of improvement (D/P) was only 1.97 (doubling) for green peach aphid, while it was 24.9 for cotton aphid. So, intrinsically, both aphids should reach higher numbers on daisy, based on this consideration.
3. No evidence in control plots was observed of a decline in plant quality due to high numbers. Aphids in controls increased in density to the final count. Therefore, final counts, not peak counts, could be used to assess biological control impacts without fear of confounding parasitoid impact with declining plant quality effects on aphids.
4. The parasitoid suppressed cotton aphid to very low levels, only 1-6% of control values, but had less effect on green peach aphid, which reached 13-34% of control values, both in single aphid treatments (Table 2).
5. Aphids of both species were more strongly suppressed by parasitoids on daisy, the better host plant of both aphids, than on pansy. The reason for this is not clear, and may relate to poorer foraging success for *A. colemani* on pansy or it may relate to poorer developmental success of parasitoid immatures developing on pansy. This is unexpected, inasmuch as it would normally be predicted that biological control would be better, not worse, when combined with the influence of plant resistance to the host.
6. The presence of a second species of aphid was not in general a positive influence on biological control. Aphid suppression increased, on average, in only one case of four and either decreased or remained unaffected in the other three.

Obj. 3. Commercial greenhouse trials. Outcomes varied tremendously among locations and are being analyzed further. In gross terms, in MA, of three greenhouse, use of banker plants could be said to have been successful in two cases, but one of these was largely due to natural control by syrphid larvae that invaded the plot. One greenhouse had so little aphid suppression, the trial had to be terminated and the third experienced good control. In NY, of four commercial locations, one experienced good control, with aphids placed on uncaged plants remaining scarce; one location experienced a high peak of aphids that dropped back quickly (one week) to levels initially placed on plants; and two locations showed a failure to control aphids, which increased steadily to unacceptable numbers. In NY, logistical problems prevented us from having an abundance of parasitized aphids on the banker plants at the start of the trial. Also, growers were inattentive to irrigating the banker plants so that the plants and thus the aphid host numbers as well as any developing parasitoids were severely affected. Finally, in some

locations, the aphid present in the greenhouse was foxglove aphid, a non-host for the parasitoid being assessed.

Obj. 4. Compatibility of two pesticides with *Aphidius colemani*. This activity is not complete. Partial data are presented in Table 3 and 4

Table 3. Numbers of live *Aphidius colemani* at various times after exposure to freshly dried residues of two pesticides, versus a water control.

Pesticide	No. live wasps (of 10/replicate) at three times post treatment (n = number of replicates)		
	2h	6h	12h
water control	9.7 (25)	9.3 (10)	8.7 (11)
pymetrozine	8.9 (30)	6.8 (12)	4.6 (10)
pyriproxyfen	8.8 (30)	No data	7.6 (10)

Table 4. Emergence of adult *Aphidius colemani* from mummies treated with either of two pesticides, versus a water control.

Pesticide	Number of emerging adults (of 10 mummies) (n= no. of replications)
water control	5.9 (18)
pymetrozine	5.0 (21)
pyriproxyfen	5.8 (12)

These data, while not yet complete, suggest that these materials will not affect emergence of wasps from mummies, but might affect adult survival if whole greenhouses are treated (spot applications to aphid infested plants might have a lesser effect).

Impacts

1. **Safeguarding human health.** In theory, if banker plants are adopted as replacement for aphicides, this might reduce worker exposure to pesticides. However, this project is at an earlier phase, assessing whether this technology works well enough to be recommended. Therefore we cannot say at this time that it has had any effect on human health, although future adoption, based on this work, might.
2. **Economic benefits.** Aphids can be cheaply controlled with pesticides. It is likely that biological control will be at least as costly, if not more so. Therefore no economic benefits are claimed from this work.
3. **Implementation of IPM.** This project assessed one new IPM strategy (banker plants for aphids). This is the first data set in North America for use of banker plants in greenhouse flower crops for aphid control. While the project did not find a high and consistent level of control with treatments as applied, it did find that the method can suppress some aphids under some conditions. The next step is to develop more information that can make the approach work over a wider set

of conditions. Interestingly, the approach is currently being adopted and is commercially available. No fact sheets or websites have yet been generated from this research. However, after analysis is complete, an extension article for Floral Notes (a MA newsletter for flower growers) will be prepared.

4. *Enhanced collaboration among stakeholders.* I am not aware that these trials have change collaboration among stakeholders in any way.

Appendices

None